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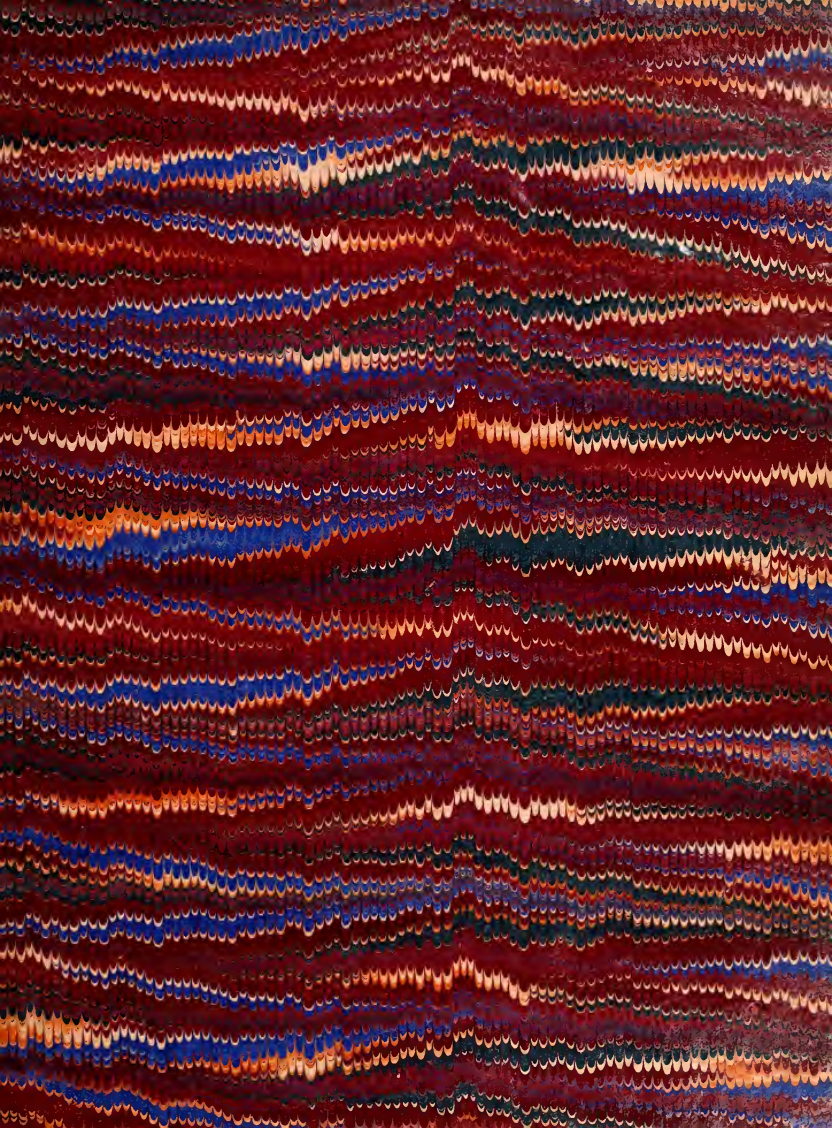
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SELECTIVE REFLECTION IN THE INFRA-RED SPECTRUM.

By

JAMES TEMPLE PORTER.

DISSERTATION
SUBMITTED TO THE BOARD OF UNIVERSITY STUDIES
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IN CONFORMITY WITH THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY.

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SELECTIVE REFLECTION IN THE INFRA-RED SPECTRUM.

Certain substances which transmit a large percentage of the incident radiation in the visible portion of the spectrum, reflect strongly in the infra-red. Of these, one of the most noteworthy is quartz. It has been shown by Professor E. F. Nichols* that in the neighborhood of wavelength 8.5μ the reflection from a quartz surface is 20 or 30 times greater than in the other parts of the spectrum, and that, consequently, in the spectrum of rays after three successive reflections these waves will lose little in intensity, whereas, those lying on either side of this value will be reduced in the ratio of $(20)^3$ or $(30)^3$ to 1. The spectrum, then, after three reflections will contain practically only the radiation of wavelength $\lambda = 8.5\mu$, and this in measurable quantity. Rubens and Nichols**, and Rubens and Aschkinass*** have employed

* E. F. Nichols, Physical Review, Vol. IV, p.297,(1897).

** Rubens and Nichols, Annalen, 60, pp.418 and 430 (1897).

*** Rubens and Aschkinass, Annalen, 65, p. 241, (1898).

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• E. P. Moseley, *Geological Survey, Vol. 17, p. 197, (1917)*.
• Moseley and Moseley, *Geological Survey, Vol. 17, p. 197, (1917)*.
• Moseley and Moseley, *Geological Survey, Vol. 17, p. 197, (1917)*.

this method, commonly known as the method of "Reststrahlen", for the detection of waves of great length in the infra-red.

In the work which has been done by these investigators it has been assumed that the positions of the reflection maxima and the absorption maxima coincide, and dispersion formulae have been used in order to predict the positions of the reflection maxima. This assumption is not entirely justifiable, and the agreement between the calculated and the observed values for the very long waves is not sufficiently conclusive. One of the objects of this research was to accumulate facts which might possibly throw some light upon the problem. The data, however, in regard to the dispersion of substances available for experiment are too limited to enable one to draw any conclusions. It is hoped, nevertheless, that the few facts here added may at some time prove useful in the solution of the problem.

Wavelength measurement by the method of "Reststrahlen" is perfectly simple, and will be explained after the apparatus has been described. The following is a list of the substances which have been studied by others and the wave-

the method, commonly known as the "method of the
for the selection of water of great value in the water
way.

To the water which has been used by these investigators
it has been assumed that the selection of the selection
method and the selection method selected, and therefore
the method used in water is provided the selection
of the selection method. This method is not entirely

indefinite, and the agreement between the selected
and the method which the water which is not
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search was to determine the water which is not
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Therefore, the method of the selection of the selection
method, and will be explained after the selection
has been described. The following is a list of the water
which has been used in the water and the water

lengths of their restatrahlen measured by this method; quartz, fluorite, sodium chloride, sylvine, mica, marble, sodium bromide and calcium bromide. A detailed discussion of these is to be found in the papers referred to above. Each substance is characterized by well marked maxima which occur in the grating spectrum after three or more successive reflections. Fourteen other crystalline compounds have been examined by the writer. Seven of them, viz. potassium dichromate, copper sulphate, tartaric acid, ammonium chloride, potassium sulphate, potassium bisulphite and potassium ferrocyanide, show unmistakable maxima at various parts of the spectrum. A few words with reference to each of these will be said after the apparatus has been described.

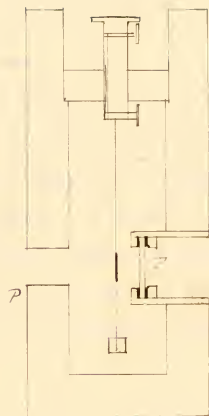
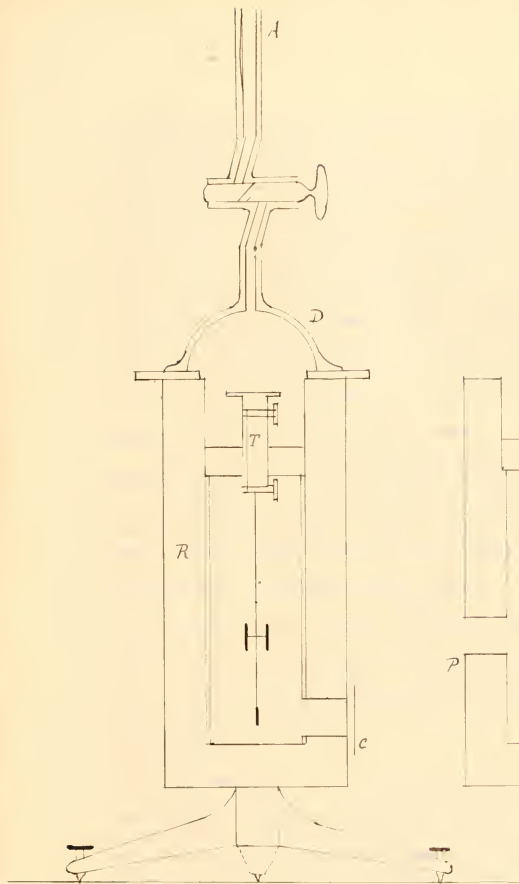
Apparatus.

Radiometer. The radiometer was selected for this work because of the great difficulty in working in this laboratory with an instrument which is highly sensitive to small changes in the electric or magnetic conditions. This reason has barred the use of bolometer and thermopile, while the radiomicrometer, the only other instru-

ment which can be used in work of this kind, for equal sensitiveness, is not so reliable as the radiometer. The latter instrument, undoubtedly the best for infra-red work in this laboratory, is objectionable on account of the absorption due to the fluorite plate. Above 11μ practically no radiation gets through. With it, therefore, measurements cannot be made on waves whose wavelengths exceed this value.

The instrument here described is in almost every respect similar to the one used by Professor Nichols at the Yerkes Observatory in the summer of 1900*. Two vertical sections at right angles to each other are shown on the following page. The scale of the diagram is one half natural size for all parts except the suspension, H, which is approximately natural size. Tube A was cemented to a drying tube containing phosphorus pentoxide with a Toepler mercury pump. On the frame supporting the pump was also placed a McLeod gauge which gave readings consistent to .001 of a millimeter of mercury. The openings at the lower end of the brass case R, three in number,

* Astrophysical Journal, Vol. 13, p. 101, (1901).





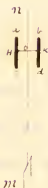
were made air tight in the following way. Over C and P glass plates were cemented by means of the rubber preparation ordinarily used for making stop-cocks air tight. The window F was closed by means of a circular fluorite plate about 2 cms. in diameter and 2 mms. thick. This plate was placed between rubber washers, which had been previously smeared with the rubber preparation, and lowered into place at the inner end of a metal tube extending almost to the centre of the case. A brass ring was then screwed down so as to hold the plate in place and secure an airtight fit. The dome D was held in place by the same rubber preparation, and cemented to the glass connecting tube with Khotinsky cement. The rate of leak of the entire system, which contained besides these openings two stopcocks, amounted to about .003 mm. in 24 hours, which is not large considering the number of possibilities for leakage.

The Suspension. - The suspension was made in the following way; a very thin rod of glass about 3 centimeters long carried a cross arm near its upper end. To the extremities of this arm were cemented, by means of hard shellac, rectangular mica vanes covered with lamp black.

were made only light in the following way. Over E and F
glass plates were connected by means of the Foster Group
which was originally used for making photo-plates and light.
The window I was placed by means of a circular lens
about 2 mm. in diameter and 2 mm. thick. This
plate was placed between Foster lenses, which are com-
monly mounted with the Foster lens, and lenses
into place by the means of a metal plate containing
holes in the center of the lens. I placed this plate
between them as it held the plate in place and secured
an airtight fit. The lens I was held in place by the
own Foster lens, and secured in the glass con-
necting them with Foster lens. The plate of lens of
the Foster lens, which contained circular holes, and
the Foster lens, secured in place. This was in 1940.
which is not being mentioned in the number of possibilities
for lenses.

The lens. - The lens was made in the 1940-
lens was a very good one of glass about 2 mm. thick
and was a very good one. The lens was
placed in the lens and secured, by means of the
lens, containing also some other lens.

The lower end of the vertical rod carried a small mirror placed at right angles to the plane of the vanes. A diagram and the exact dimensions of this suspension are given below.



$m\ n = 32$ millimeters.

Vane on the right of the diagram.

Length = .5313 cm.

Width = .0685 cm. (mean)

Area = 3.637 sq. mm.

Vane on the left of the diagram.

Length = .5305 cm.

Width = .0687 cm. (mean)

Area = 3.641 sq. mm.

ab (outside measurements) = .5401 cm

cd " " = $\frac{.5427}{2}$ "
 Mean = .5414 cm.

$1/2 \times .5414 = .2707$ cm.

OH (measured) .2728 cm.

Size of mirror 3 x 3 sq. mm.

Total weight 6 $3/4$ mg.

A quartz fiber attached the suspension to the torsion head.

Sensitiveness.

In the radiometer it is well known that there is a

critical pressure at which the sensitiveness is a maximum. The accompanying curve shows the relation existing between sensibility and pressure for the instrument under consideration. Abscissae are pressures, ordinates deflections. In plotting this curve there was used a 76 volt direct current. Nernst filament supplied by a storage battery with a constant current of 0.32 of an ampere.

At the time the observations were made the battery was being used for no other purpose. It will be observed that the maximum sensibility falls at about 0.15 of a millimeter. This critical pressure varies greatly in different instruments. Values ranging from .05 mm in Nichols' radiometer to 0.15 mm in this case, are to be found. It has been suggested that the McLeod gauges which have been used to measure the pressure are responsible for the discrepancy.

The sensitiveness was also tested by means of a paraffin candle in order to compare it with that of other instruments of a similar construction. The three radiometers compared in the following table are, Radiometer used by Nichols * at the Yerkes in 1900. One used by Stewart** at

* E. F. Nichols, l.c.

** Physical Review, 13, p. 263, (1901).

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Journal of Management Education 36(7) 809-821

1. The first step in the process of identifying a problem is to define the problem. This involves identifying the symptoms of the problem and determining the scope of the problem. Once the problem has been defined, the next step is to identify the causes of the problem. This involves identifying the factors that are contributing to the problem and determining the underlying causes. Once the causes have been identified, the next step is to develop a plan of action. This involves identifying the steps that need to be taken to solve the problem and determining the resources that will be needed to implement the plan. Once a plan of action has been developed, the next step is to implement the plan. This involves carrying out the steps that have been identified in the plan and monitoring the progress of the implementation. Finally, the last step in the process is to evaluate the results of the implementation. This involves determining whether the problem has been solved and whether the resources have been used effectively.

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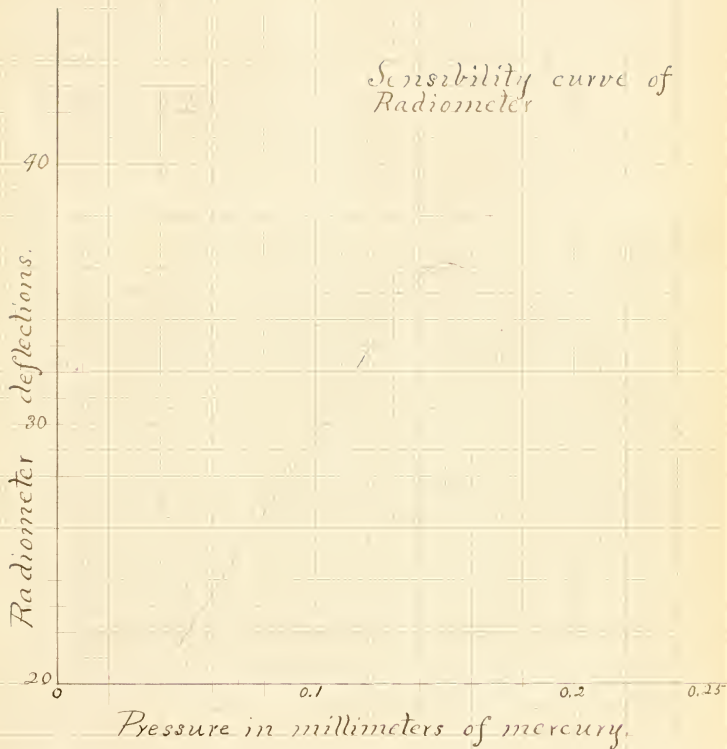
and in which it was also found in the

• 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 2681, 2682, 2683, 2684, 2685, 2686, 2687, 2688,

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*Sensitivity curve of
Radiometer*



Cornell in 1901. Radiometer used in this investigation. The deflections have been reduced so that the numbers correspond to deflections on a scale one meter from the mirror due to a candle one meter from the vane.

Comparison of sensibilities of various radiometers .

Comparison source - a paraffin candle.

By whom construct- ed.	Vanes.	Area of vane in sq. mm.	Deflec- tion. Can- dle & scale 1 m off.	Deflec- tion per sq. mm.	Relative sensibil- ities.	Time re- quired for max. def. in sec.
Nichols.	Mica.	3.14	395	126	1.0	5.5
Stewart.	Plat- inum.	30	1467	49	0.4	40
"	Mica.	30			1.5	300
Porter.	Mica.	3.64	1000	275	2.0	45

Difficulties.

The difficulties met with in working with a radiometer have several times been enumerated, but a few words with reference to them in the present case may not be out of place. In general troubles arise from four sources; namely, (1) unsteadiness of the zero position, (2) mechanical jarring, (3) leakage of the radiometer case and connections and (4) static charges on the vanes. Leakage and charges on the vanes gave

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practically no trouble after the instrument was finally gotten into working condition. The rate of leak as has been seen was too small to be in the least annoying, and the size of the vanes permitted them to be placed at such a distance from the fluorite window that, while still fulfilling the conditions of sensitiveness, they could turn completely round without striking against it and consequently becoming charged as frequently happens in the case of larger suspensions.

Unsteadiness of the zero position has given far more trouble. In so sensitive an instrument it is to be expected that such a difficulty will arise. This variation of the zero in the radiometer may be reduced in two ways; (1) by care in the construction of the suspension and (2) by guarding against irregular distribution of the radiant energy reflected from objects situated obliquely in front of the fluorite window.

If the suspension were perfectly symmetrical with reference to the axis of rotation, any source of radiation, no matter how intense, to which the vanes are equally exposed, should produce no effect. It is, however, not possible to secure perfect symmetry, therefore deflections

principally an economic matter and therefore was likely
 rather late reaching resolution. The fact is that as has
 been seen the fact itself is in the least surprising, and
 the fact of the same period from the point of view
 a distance from the economic situation, which will not
 fulfill the conditions of modernization, they could not
 completely break without fulfilling almost if not conse-
 quently becoming almost as frequently happens in the
 case of other countries.

Consequently in the same position was given for
 each country. It is necessary to understand it is to
 be suggested that each a different will arise. This ad-
 vantage of one side in the present and is possible in
 the way; (1) by one in the development of the na-
 tional and (2) by having greater internal disci-
 pline of the present energy released than others situated
 outside in terms of the economic situation.

It has suggested some particularly significant with re-
 ference to the fact of modernization, and states of modern-
 ization, no matter how far, no matter the degree of modern-
 ization, should produce the effect. It is, however, not
 possible to secure perfect security; complete satisfaction

may arise due either to the unequal absorption of radiant energy by the vanes, or to inequality in the length of the two arms, or to both these causes combined.

Furthermore, the vanes are located at the inner end of a comparatively long tube, consequently, if the objects situated obliquely in front of this tube radiate unequally it is possible that both vanes may not be at the same time exposed to the action of equal forces. There will therefore result a rotation. This difficulty may be overcome by resorting to screens which will assist in securing a uniform distribution of the energy in the neighborhood of the radiometer. The figures given above give some idea in regard to the symmetry of the suspension and the diagram of the apparatus shows the positions of the sheet iron screens about the radiometer.

The source of the greatest annoyance has been mechanical jarring. The radiometer as well as other parts of the apparatus was supported upon marble slabs resting upon iron bars built into the wall of the laboratory. Nevertheless it was impossible to make observations during the day time. In the experiments on the Reststrahlen the readings were all taken between the hours of 8 and 12 P.M.

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It is possible that you will not be at the same time as the other people who will be there. It is possible that you will not be at the same time as the other people who will be there.

low pass filter. This filtering may be over-
come by resorting to common voice with a re-
sulting a similar situation at the output as the input
signal of the transmitter. The signal given above is
not that is not for example in the case of the
and the signal of the signal above the signal is
the first two signals above the signal.

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when there was no other person in the building. Even under these conditions much time was lost in waiting for the effects of passing cars to subside. I have found that when perfect quiet is obtained the deflections of this instrument are entirely reliable to one tenth of a millimeter on a scale one meter off.

The spectrometer. - The divided circle used is one which has been employed in this laboratory for testing small plane gratings. This circle was set upon a heavy iron base and a steel arm so mounted that it, together with the circle, could be rotated in a horizontal plane about an axis passing through the centre of the circle. This arm carried three things; (1) a small concave mirror 52 cm radius of curvature, made by Bausch and Lomb, (2) a Nernst filament, the ballast being placed on the wall, and (3) a wire grating so mounted that the axis of rotation lay in the plane of the wires. The second mirror of the spectrometer which was of the same size and make as the one mentioned above was fixed. The arrangement of the apparatus is shown by the diagram on the following page which represents a horizontal section.

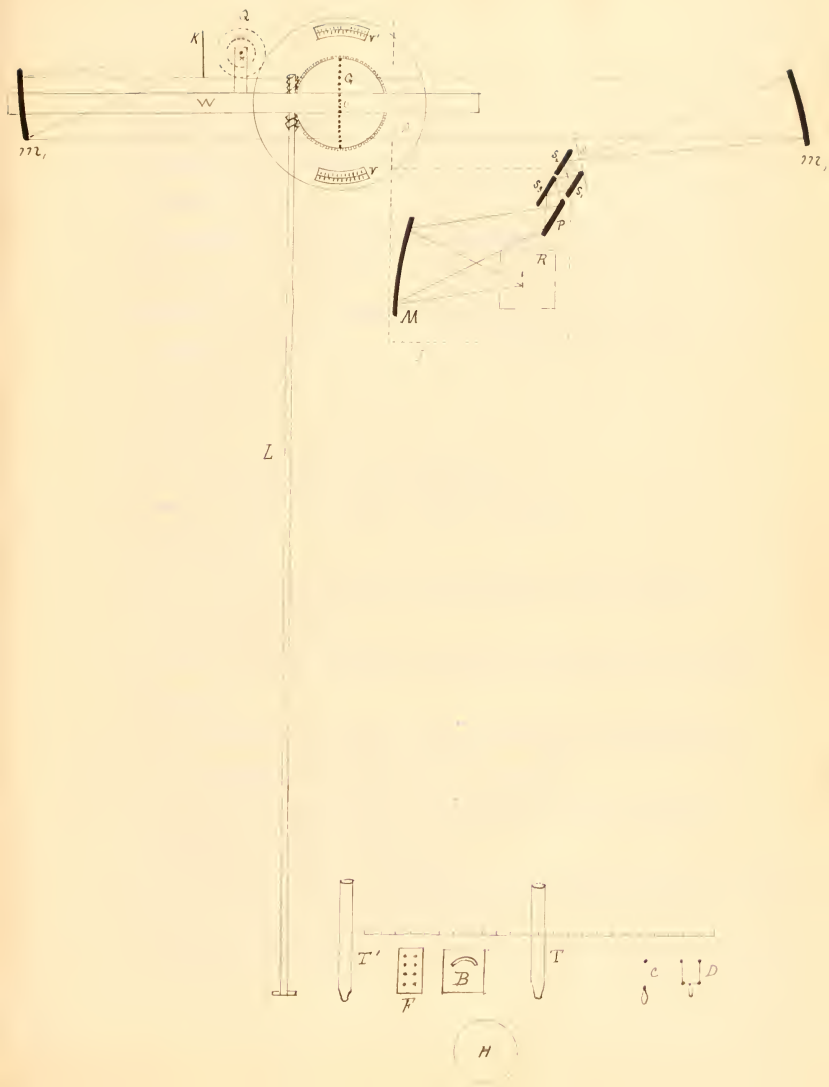
The letters indicate the following;
A spectrometer table.

from there was an almost perfect fit. The
 other three specimens were found in the same
 the effects of heating were to be noted. I have found that
 when heated water is obtained the following of this
 treatment are entirely reliable to the point of a milli-
 meter on a scale one meter off.

The Apparatus. - The distilled water used in our
 work was once subjected to this laboratory for testing
 small glass vessels. This device was used upon a heavy
 iron base and a glass tube was mounted over it, together with
 the device, which is placed in a horizontal glass vessel
 an axis passing through the center of the circle. This
 was carried three inches; if a small reservoir with a
 on radius of curvature, made by hand and foot, (1) a
 heavy filament, the filament being placed on the wall and
 (2) a wire passing so mounted that the axis of rotation
 lay in the plane of the wire. The round mirror of the
 apparatus which was of the same size was made as a
 one revolution device was fixed. The arrangement of the
 apparatus is shown by the diagram in the following table
 which represents a horizontal section.

The letters indicate the following:

A - Spectrometer lens.





n Nernst filament.

Q sheet iron screens.

W steel bar.

m, m. silver on glass concave mirrors .

G grating.

K movable screen operated by a string in the hand of the
observer at H.

V, V' verniers.

S slit.

S, S, S₁ surface under consideration.

M large silver on glass concave mirror.

R radiometer.

C and D switches in the incandescent lamp circuits.

F a resistance box.

L a brass rod by means of which the bar W can be turned
about O.

T a telescope for reading the radiometer deflections .

T' a telescope for reading the vernier .

B an ammeter indicating the strength of the current
through the Nernst filament .

I a sheet iron screen surrounding the radiometer and mirror .

P a plane silver on glass mirror.

The large mirror M was made by Bausch and Lomb, and has

• *Journal of the American Medical Association* 2000;283:2537-2542

• **உயிரினங்கள்** உயிர் தரும் பகுதி

• **Good Luck!**

• **gratuitous answers** = no pay for a service

• **1996** **1997** **1998** **1999** **2000** **2001** **2002** **2003** **2004** **2005** **2006** **2007** **2008** **2009** **2010** **2011** **2012** **2013** **2014** **2015** **2016** **2017** **2018** **2019** **2020** **2021** **2022** **2023** **2024** **2025** **2026** **2027** **2028** **2029** **2030** **2031** **2032** **2033** **2034** **2035** **2036** **2037** **2038** **2039** **2040** **2041** **2042** **2043** **2044** **2045** **2046** **2047** **2048** **2049** **2050** **2051** **2052** **2053** **2054** **2055** **2056** **2057** **2058** **2059** **2060** **2061** **2062** **2063** **2064** **2065** **2066** **2067** **2068** **2069** **2070** **2071** **2072** **2073** **2074** **2075** **2076** **2077** **2078** **2079** **2080** **2081** **2082** **2083** **2084** **2085** **2086** **2087** **2088** **2089** **2090** **2091** **2092** **2093** **2094** **2095** **2096** **2097** **2098** **2099** **2100** **2101** **2102** **2103** **2104** **2105** **2106** **2107** **2108** **2109** **2110** **2111** **2112** **2113** **2114** **2115** **2116** **2117** **2118** **2119** **2120** **2121** **2122** **2123** **2124** **2125** **2126** **2127** **2128** **2129** **2130** **2131** **2132** **2133** **2134** **2135** **2136** **2137** **2138** **2139** **2140** **2141** **2142** **2143** **2144** **2145** **2146** **2147** **2148** **2149** **2150** **2151** **2152** **2153** **2154** **2155** **2156** **2157** **2158** **2159** **2160** **2161** **2162** **2163** **2164** **2165** **2166** **2167** **2168** **2169** **2170** **2171** **2172** **2173** **2174** **2175** **2176** **2177** **2178** **2179** **2180** **2181** **2182** **2183** **2184** **2185** **2186** **2187** **2188** **2189** **2190** **2191** **2192** **2193** **2194** **2195** **2196** **2197** **2198** **2199** **2200** **2201** **2202** **2203** **2204** **2205** **2206** **2207** **2208** **2209** **2210** **2211** **2212** **2213** **2214** **2215** **2216** **2217** **2218** **2219** **2220** **2221** **2222** **2223** **2224** **2225** **2226** **2227** **2228** **2229** **2230** **2231** **2232** **2233** **2234** **2235** **2236** **2237** **2238** **2239** **2240** **2241** **2242** **2243** **2244** **2245** **2246** **2247** **2248** **2249** **2250** **2251** **2252** **2253** **2254** **2255** **2256** **2257** **2258** **2259** **2260** **2261** **2262** **2263** **2264** **2265** **2266** **2267** **2268** **2269** **2270** **2271** **2272** **2273** **2274** **2275** **2276** **2277** **2278** **2279** **2280** **2281** **2282** **2283** **2284** **2285** **2286** **2287** **2288** **2289** **2290** **2291** **2292** **2293** **2294** **2295** **2296** **2297** **2298** **2299** **2300** **2301** **2302** **2303** **2304** **2305** **2306** **2307** **2308** **2309** **2310** **2311** **2312** **2313** **2314** **2315** **2316** **2317** **2318** **2319** **2320** **2321** **2322** **2323** **2324** **2325** **2326** **2327** **2328** **2329** **2330** **2331** **2332** **2333** **2334** **2335** **2336** **2337** **2338** **2339** **2340** **2341** **2342** **2343** **2344** **2345** **2346** **2347** **2348** **2349** **2350** **2351** **2352** **2353** **2354** **2355** **2356** **2357** **2358** **2359** **2360** **2361** **2362** **2363** **2364** **2365** **2366** **2367** **2368** **2369** **2370** **2371** **2372** **2373** **2374** **2375** **2376** **2377** **2378** **2379** **2380** **2381** **2382** **2383** **2384** **2385** **2386** **2387** **2388** **2389** **2390** **2391** **2392** **2393** **2394** **2395** **2396** **2397** **2398** **2399** **2400** **2401** **2402** **2403** **2404**

069 To have had his hand at it before he got too old.

H. J. H. van der Vliet

• **अनुसंधान** • **व**

• **Page 5**

[illegible]

Y. Igarashi et al.

— 2007-2008 年 2 月 27 日 —

estimation of the probabilities of the different types of errors.

• **Case Study** •

It is a fact that the majority of the population in the United States is of European descent, and the majority of the population in the United States is of European descent.

2010

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malware was not detected and associated with 15

1999, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 2681, 2682, 2683, 2684, 26

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• **Example:** A car starts from rest and accelerates at 2 m/s^2 . How fast is it moving after 5 seconds?

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a diameter of 12 cm and a radius of curvature of 26 cm. All the mirrors used were very good.

In order to read the vernier V by means of the telescope T' a small plane mirror was mounted above it making an angle of 45° to the vertical. A miniature incandescent lamp, which could be turned on and off by means of a switch near the observer at H, illuminated the scale and vernier. It can be seen from the arrangement of the apparatus that while taking a series of readings it is entirely unnecessary for the observer at H to change his position and this rarely occurred.

The source.- The source was a 76 volt .44 of an ampere direct current Nernst filament supplied by a storage battery, which while readings were being taken was in use for no other purpose save for supplying the 14 volt incandescent lamps which illuminated the scale and vernier. These, as a rule, were kept burning continuously during a series of observations.

The source circuit contained in series a resistance box and milliammeter so placed that the current could be watched, and if necessary controlled, while readings were being taken without the observer moving from position.

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The current variation was very small, never exceeding a hundredth of an ampere and frequently absolutely no change in the reading of the ammeter could be detected.

The grating.- The grating was made in a way similar to that described by Rubens and DuBois in Naturw. Rundsch. 8, (No. 36) 1893. A heavy brass frame, represented in



the diagram, was placed in a lathe, the ends of two wires of as nearly the same diameter as possible soldered at A, and wound under tension about M and N. After perhaps five centimeters of the length

of the frame had been covered in this way, the wires were soldered at B and the whole stretched by means of nuts H and K provided for the purpose. One of the wires was then cut and carefully unwound, while the remaining one was made fast to the brass pieces M and N by depositing electrolytically upon them a comparatively heavy coating of copper. This done the wire on one side was cut away. The spacings between the wires of a grating made in this way are very nearly equal to the diameter of the wire. The grating constant was determined by means of a divid-

[illegible]

ing engine as follows. A setting was made on the edge of each wire and the value of each space determined for the whole grating. The mean of these values was then averaged with the value of the constant found by taking the first and last readings and dividing the difference between them by the number of spaces. The value of the constant for the grating used in the wavelength determination was found to be 0.2414 of a millimeter.

Adjustments were made in the following way. After having first placed the grating G so that the plane of the wires included the prolongation of the axis of rotation, as nearly as this direction could be determined, the mirror m_1 was moved along W until the reflected beam became parallel, then rotated about a vertical axis until normal incidence upon the grating was secured. By means of m_2 the spectrum was brought to a focus in the plane of the slit S. These adjustments having been made it was then only necessary to turn the rod L in order to bring any desired portion of the spectrum upon the slit. If the slightest change in the angle of deviation was to be indicated by the radiometer, it was necessary that the image of the filament and the slit S should have exactly the same width, and

since the mirrors m_1 and m_2 had the same focal lengths, S had to have a width equal to the diameter of the filament in order to secure this result. This width was generally slightly less than one millimeter.

As soon as the current begins to flow through a Nernst filament the filament twists out of its original position. Observation however showed that after the current was once started and the filament adjusted parallel to the slit there was no relative shift of the image and slit during a series of observations.

The surfaces S_1, S_2, S_3 , supported on comparatively heavy iron blocks, resting on a wooden platform, were placed at about the angle represented in the diagram, no special care, however, being taken to secure accuracy in this respect. The mirror M focused the image of the filament on the radiometer vane which was slightly smaller than the image itself.

The method of measurement is this; note the spectrometer reading when the central image is focused on the vane, pass the spectra across the slit by turning L and if the surfaces show selective reflection for a particular wavelength, the deflections of the radiometer will rise to a maximum as that portion of the spectrum falls on the

slit. The difference between the spectrometer readings in the two cases is the angular deviation. The sine of this angle times the grating constant, if the spectrum be the first order, gives the wave-length.

Before making any new measurements it was thought best to repeat some which had already been made. For this purpose four quartz plates 4 x 4 cm. were placed at the points indicated in the diagram. The sensibility of the radiometer was such that the aperture of the mirror m_1 had to be reduced considerably in order to bring the deflections within the range of the scale. The value of the wavelength determined from the position of the first maxima was 8.14μ . Since this value was much too low according to the measurements of Rubens and Nichols, and since no special care had been exercised in procuring normal incidence upon the grating, the adjustments were all made again in as careful a manner as possible. The mirror m_1 was moved until the diameter of the beam reflected across the room remained constant. In order to secure normal incidence a long narrow mirror with the silvered side next to the wires was placed carefully on the grating

also. The absorption spectrum was observed in the same way as the emission spectrum. The line of the spectrum was observed in the same way as the emission spectrum. The line of the spectrum was observed in the same way as the emission spectrum.

Before making any measurements it was found

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above the portion which was being used, and the mirror m, turned about a vertical axis until the reflected image of the filament lay in the prolongation of the filament itself. The wires of the grating and slit S were arranged parallel to each other by means of a fine silk thread plumb line viewed through a telescope. The filament was then adjusted parallel to S. These adjustments were of course all made after the spectrometer table had been leveled. The quartz surfaces were then put in place, and the positions of the first maxima on either side of the central image determined as follows. The observer at H moved the spectrum across the slit S by turning the rod L until he was sure he had passed beyond the position of the maximum in the 1st order spectrum. L was then turned slowly in the reverse direction as the observer watched the action of the radiometer through the telescope T. When it became evident that the maximum was approaching the slit of the spectrometer the screen K was lowered and when the steady conditions were reached K was raised and the deflection noted. K was then again lowered and another setting made, and so on until the first spectrum on the opposite side of the central image was reached. In the

neighborhood of the position of maximum deflection settings at every minute of arc on the spectrometer were made, care being taken always to make the setting by turning L in the same direction. In order not to bias the judgment no differences between spectrometer readings were taken until the observations were completed. Regarding the position of the central image as the zero on the spectrometer the positions of the maxima were on the one side $1^{\circ}-58'$ on the other $1^{\circ}-58'$. For a grating constant equal to .2414 mm the value of the wavelength for this angle is 8.28μ . Although two different gratings and four different sources namely; a Nernst filament 110 V. A.C., a Nernst filament 76 V. D.C., a Welsbach mantle and a hot platinum wire have been used I have been totally unable to obtain a value higher than this. It is with some hesitation that I give these results, my only excuse being that I have sought diligently for a source of error and have been able to find none. Objection might be raised to the use of a Nernst filament without a slit. To this it seems only necessary to say that the value of the wavelength obtained when the filament was replaced by a Welsbach and slit was 8.25μ . Frequently after having determined the positions of the three maxima i. e., the first order on the left, the cen-

[illegible]

tral image and the first order on the right, the spectra were again shifted across the slit and the positions of the three maxima again determined, with the same result within the limits of error of observation, thus always showing that the apparatus underwent no change during a series of observations.

Aschkinass (Annalen 65, p. 241, (1898) has found that marble (white) reflects strongly in the neighborhood of wavelength 6.7μ which value he obtained by the method of Reststrahlen. The value I have obtained for white marble is 6.77μ .

The remainder of this paper will be devoted to a consideration of substances whose Reststrahlen have not been determined before. It was not possible to cut the crystals with any reference to the optic axis, nor does this seem necessary, for the experiments with quartz have shown that the phenomena are independent of the direction in which the faces are cut. Furthermore owing to the small size of the crystals the number of surfaces used has been uniformly only three.

Potassium dichromate. - Crystals of this substance readily take a high polish. In area the surfaces obtained varied from three to six square centimeters. The curve is plotted

in the way usually employed in measurements of this kind with spectrometer readings as abscissae and deflections of the radiometer as ordinates. The curve is therefore symmetrical about the maximum deflection corresponding to the central image.

In order to make clear the meaning of this as well as the curves that follow, I have added another which shows the distribution of the energy from a 76 V. D.C. Nernst glower in the grating spectra, from the central image out beyond 10μ in the first order spectrum. This curve was obtained by substituting for S, S_2, S_3 silver on glass mirrors. The maximum deflection in the central image is not given because it was too large to be read on the scale, notwithstanding the fact that the aperture of the mirror m_1 was cut down to the size of a pin head. ABCD shows the energy distribution in the first order spectrum. B is the point of maximum emission of energy from the source. Its angle of deviation is approximately $20'$ which corresponds to a wavelength $\lambda = 1.4\mu$. Assuming the law $\lambda_{\text{max}} \theta = \text{const.}$, we get for the temperature of the glower 2062°C . Abs.

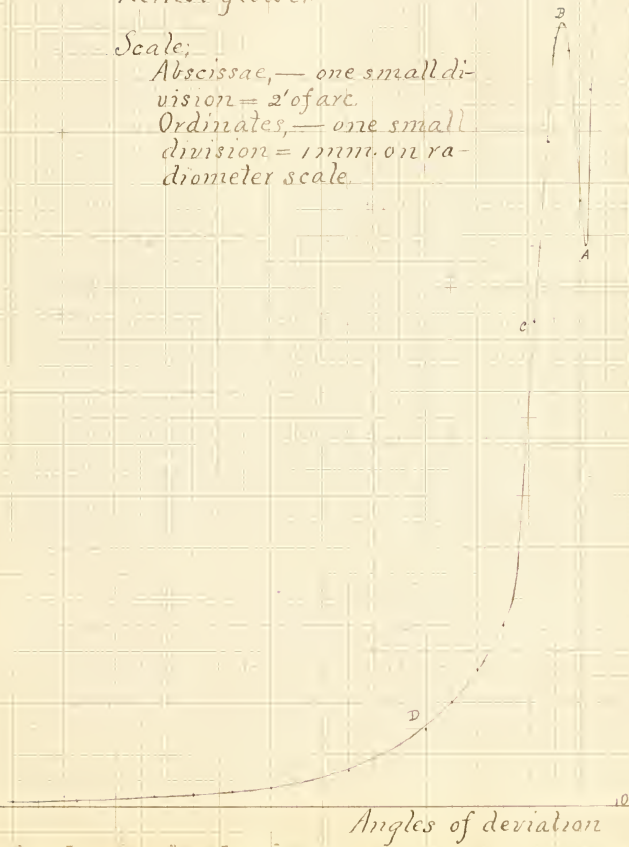
In all the curves which follow we find these emission maxima on either side of the central image. An examination

Curve showing the distribution of energy in the grating spectra of a 76 V. DC. Neon glow.

Scale;

Abcissae, — one small division = 2' of arc.

Ordinates, — one small division = 1 mm. on radiometer scale.



Radiometer deflections.

Angles of deviation

of the curves, however, will show that there is some variation in their position relative to the central image. This shifting may be due to several causes. In the first place the current through the filament was not the same for any two curves, and in the second, if the substance should possess any strong reflecting power in the neighborhood of this maximum, the result would be ^{an} apparent shifting of the energy maximum, in either one direction or the other.

We will return to the consideration of the potassium dichromate curve. D and E, then, are the maxima due solely to the energy emission of the source. By increasing the number of surfaces these could doubtless be cut out as was found to be the case with quartz. With three quartz surfaces these maxima occur in approximately the same position as in all the curves here given, but by increasing the number of surfaces to four they disappear, although the curve slopes off gradually at the base on either side of the central image and does not fall to zero abruptly as does the one given by Rubens and Nichols for four surfaces. The cause of this difference is undoubtedly to be found in the greater sensitiveness of the instrument used in this work. A and C are the first order spectra of the waves

Curve showing the selective
reflection of
Potassium Dichromate.

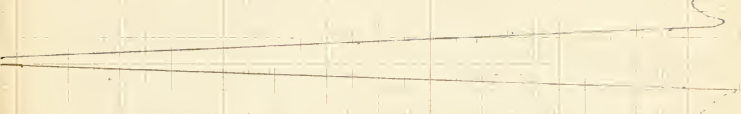
Scale,

Abscissae, — one small division

= 2' of arc

Ordinates, — one small division

= 1 mm on radimeter
scale



most strongly reflected by the substance, or what has been termed the Reststrahlen. In comparing this curve with the energy curve of the source it is to be remembered that the aperture of the mirror m , in this case was the total aperture, while in the case of the energy curve obtained with the silver mirrors it was not over a millimeter.

The angles of deviation of A and C are $2^{\circ} - 28'$ and $2^{\circ} - 26'$ respectively. The wavelength corresponding to $2^{\circ} - 27'$ is 10.31μ .

was already satisfied at the moment, he took the book
 and the other two. It was a very old book, and the
 cover of the book is of a brownish color. The
 title of the book is "The History of the
 World" and the author is "The World".

The book is very old and the cover is of a brownish color.
 The title of the book is "The History of the World" and the
 author is "The World". The book is very old and the cover
 is of a brownish color.

10.11.

Copper Sulphate.

The quality and size of these surfaces were similar to those of the dichromate. The curve presents the same peculiarities only appearing different because of the difference in the scales to which the two are drawn.

Positions of the maxima.

Energy maxima, $18' \frac{1}{2}$ and $20' \frac{1}{2}$

Reststrahlen maxima, $47' \frac{1}{2}$ and $46' \frac{1}{2}$

The wavelength corresponding to $47'$ is 2.30μ .

General Remarks

The quality and size of the specimens were similar in those of the specimens. The only difference to observe was that the specimens were of the same size as the specimens in the same size.

Results of the analysis

Results of the analysis

Results of the analysis

The results of the analysis are as follows:

Curve showing selective reflection of
Copper Sulphate

Radiometer deflections. Scale, - one division = 1 mm deflection.

Angles of deviation. Scale, - one division = 1' of arc.

Tartaric Acid.

The reflecting surfaces obtained in this case were exceptionally good, but the areas of the surfaces were very small, not over 3 sq. cm. for the largest S_3 .

Positions of the maxima.

Energy maxima, 19' and 20'

Reststrahlen maxima, $1^\circ - 21'$ and $1^\circ - 22'$.

Wavelength corresponding to $1^\circ - 21'1/2'$ is 5.72μ .

Testate fish.

The following testate fish were found in the same
 were exceptionally good and the number of the testate were
 very small, but over 500. For the purpose of

Testate of the same.

Every small 10' and 20'

Testate of the same 10' and 20'

Testate of the same 10' and 20'

Curve showing the
selective reflection of
Tartaric Acid.

Radiometer deflections, Scale— one division = 2mm. deflection

Angles of deviation, Scale,— one division = 2' of arc.

Ammonium Chloride.

The surfaces of ammonium chloride were not so good, but were much larger than in the above cases.

Position of the maxima.

Energy maxima, 19' and 21'

Reststrahlen maxima. 47' and 48'

Wavelength corresponding to 47 1/2' is 3.44μ .

improved colorless.

The addition of another equivalent was not made.

There were some changes in the color.

Position of the amino

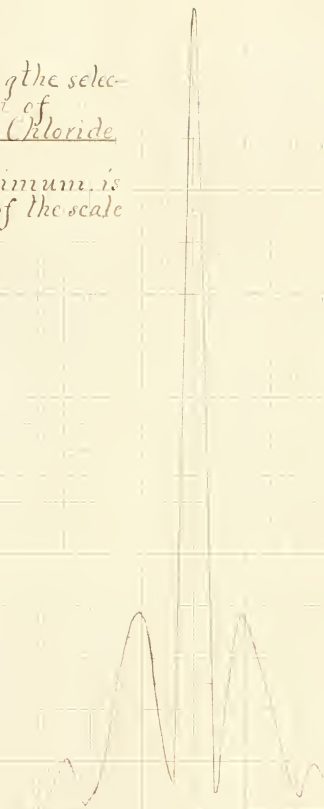
Energy barrier 10, 11, 12, 13

Reaction conditions 14, 15, 16

Physical characterization 17, 18, 19, 20

Curve showing the selective reflection of
Ammonium Chloride

Central maximum is
drawn to $\frac{1}{2}$ of the scale



Radiometer deflections. Scale— one division = 1 mm deflection.

Angles of deviation. Scale, — one division = $2'$ of arc

Potassium Sulphate.

Large crystals of this substance were not at my disposal. Aggregates of small ones, however, were found which were so compact that surfaces were readily polished on them. Although the surfaces obtained in this way were somewhat discontinuous the amount of energy reflected was amply sufficient for the measurements. The area of the largest was not over 4 sq. cm.

Positions of the maxima.

Energy maxima, 21' and 21'

Reetstrahlen maxima, 2° - and 2°

Wavelength corresponding to 2° is 8.42μ .

• <http://www.pearsoned.com>

On 24 June 1964, the following information was received from the Bureau of the Census, Washington, D.C.:

doi:10.1017/S0007122612000052

• *William - 4th. In position*

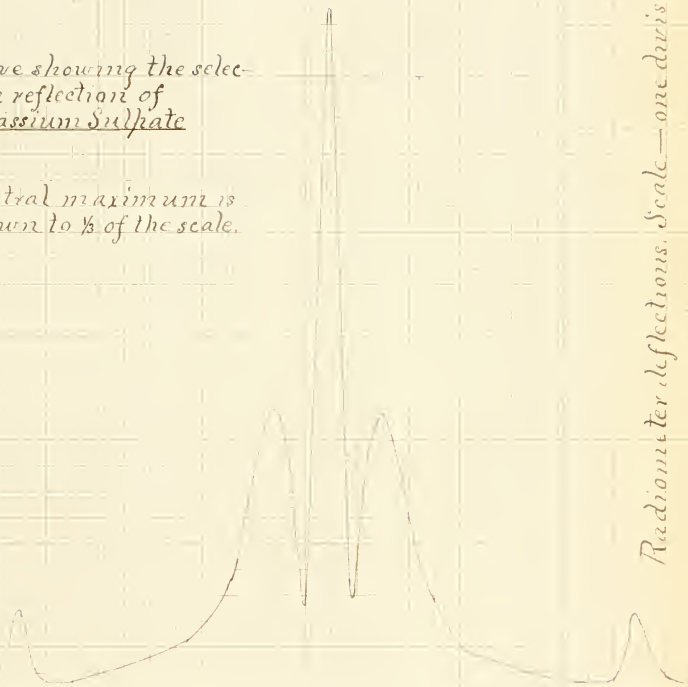
© 2010 John Wiley & Sons, Ltd. *J. Forecast.* 30, 1031–1042 (2011)
DOI: 10.1002/for

1. *See* e.g., *United States v. Gurnea*, 199 F.3d 1005, 1010 (9th Cir. 2000).

Table 1. *Mean and standard deviation of the variables of the study*

Curve showing the selective reflection of
Potassium Sulphate

Central maximum is
drawn to $\frac{1}{3}$ of the scale.



Radiometer deflections. Scale — one division = 1 mm. deflection.

Angles of deviation. Scale, — one division = 2' of arc.

Potassium Bisulphite.

These surfaces were also obtained by polishing aggregates of small crystals as in the last case.

Positions of the maxima.

Energy maxima, 20° and $21\frac{1}{2}^\circ$

Reststrahlen maxima, $1^\circ - 56'$ and $1^\circ - 58'$

Wavelength corresponding to $1^\circ - 57'$ is 8.21μ .

Technical Description.

These studies were also carried out in the laboratory
 in order to obtain a better knowledge of the behavior of the material.

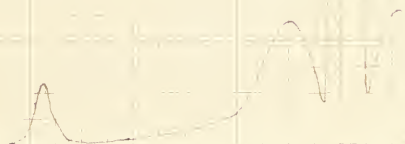
Technical description of the material.

These studies were also carried out in the laboratory

in order to obtain a better knowledge of the behavior of the material.

These studies were also carried out in the laboratory

Curve showing the selective reflection of
Potassium Bisulphite



Angles of deviation. Scale, - one division = $2'$ of arc.

Radionometer deflections. Scale - one division = 2 mm deflection.

Potassium ferrocyanide.

The somewhat cheesy nature of potassium ferrocyanide rendered it difficult to obtain surfaces of sufficient reflecting power. Success was finally obtained and the accompanying curve shows the results.

Positions of the maxima.

Energy maxima, 22' and 24'.

Reststrahlen maxima, $1^{\circ} - 9'$ and $1^{\circ} - 9'$.

Wavelength corresponding to $1^{\circ} - 9'$ is 4.84μ .

Positional Error

The amount of energy radiated by a source of radiation is proportional to the distance from the source. The amount of energy radiated by a source of radiation is proportional to the distance from the source. The amount of energy radiated by a source of radiation is proportional to the distance from the source.

and the accompanying curve shows the results.

Position of the source.

Energy radiated 10' and 20'.

Position of the source 1 - 2' and 1 - 3'.

Position of the source 1 - 4' and 1 - 5'.

Curve showing the selective reflection of Potassium ferrocyanide.

Central maximum is drawn to $\frac{1}{2}$ of the scale.

Angles of deviation Scale, - one division = $2'$ of arc

Radiometer deflections. Scale, - one division = mm deflection

Summary of Results.

Wavelengths of the Reststrahlen from various substances below 11μ determined from measurements on 1st order spectra.

Substance	Source	Wavelength
Quartz	76V.D.C.Nernst Filament	8.28μ
Marble(white)	" " "	6.77μ
Potassium dichromate	110A.C.Nernst Filament	10.31μ
Copper sulphate	" " "	2.30μ
Tartaric acid	76 V.D.C. " "	5.72μ
Ammonium chloride	" " "	3.44μ
Potassium sulphate	" " "	8.42μ
Potassium bisulphite	" " "	8.21μ
Potassium ferrocyanide	" " "	4.84μ

Summary of Results.

Wavelengths of the absorption lines for various substances below 11 μ determined from calculations on first order spectra.

Substance	Source	Wavelengths
Quartz	25V.D.1. Water filter	8.28
Salt (NaCl)	" "	8.77
Potassium dichromate	110A.C. Water filter	10.31
Copper sulphate	" "	10.50
Tartaric acid	25 V.D.C. "	10.73
Ammonium chloride	" "	11.11
Potassium sulphate	" "	11.12
Potassium nitrate	" "	11.13
Potassium ferrioxalate	" "	11.84

The following table giving the substances whose Reststrahlen have been determined by others is added for the sake of completeness.

Substance	By whom measured	Wavelengths in μ .
Quartz	Rubens and Nichols	8.50, 9.02, 20.75
Mica	" "	9.20, 18.40, 21.25
Fluorite	" "	24.4
Rock Salt	Rubens and Aschkinass	51.2
Sylvine	" "	61.1
Marble	Aschkinass	6.69, 29.4

Before concluding I wish to say a few words in regard to some experiments which have been made with a view to determining whether or not the waves in the neighborhood of 8.5μ can be elliptically polarized by reflection from a quartz surface. The fact that one is compelled to keep both the source and the radiometer in fixed positions has rendered the necessary adjustments very difficult. For polarizer and analyzer I have used two

The following table giving the wavelengths whose refractive indices have been determined by others is added for the sake of completeness.

Substance	By whom measured	Wavelengths in microns
Quartz	Wulff and Wiedemann	8.50, 9.00, 10.75
Mica	" "	9.50, 11.40, 21.50
Fluorite	" "	14.4
Rock salt	Wulff and Wiedemann	21.5
Sylvine	" "	61.1
Selenite	Wiedemann	6.00, 29.4

Before concluding I wish to say a few words in regard to some experiments which have been made with a view to determining whether or not the waves in the neighborhood of 8.5 microns can be efficiently generated by reflection from a quartz crystal. The fact that one is compelled to know both the source and the refractor is fixed conditions has rendered the necessary adjustments very difficult. The polarizer and analyzer I have used two

small fluorite plates about 2 1/2 centimeters square. At this wavelength fluorite reflects only about 2% of the energy incident upon it, consequently, by the time the radiations have suffered reflection at two fluorite and three quartz surfaces there is very little energy left at one's disposal. Although I have not succeeded in carrying out the experiment to a definite conclusion the preliminary tests have shown that the radiometer is sufficiently sensitive to detect the small quantity of energy with which one has to deal. I therefore hope to obtain some results which will be conclusive on this point.

To Professor Joseph S. Ames, under whose direction this work has been done, I am greatly indebted, chiefly for his valuable suggestions and his unfailing interest.

small fluorite plates about $2 \frac{1}{2}$ centimeters square. At this wavelength fluorite reflects only about 1% of the energy incident upon it, consequently, by the time the radiation has been reflected at two fluorite and three quartz surfaces there is very little energy left at one's disposal. Although I have not succeeded in carrying out the experiment to a definite conclusion the preliminary tests have shown that the radiator is sufficiently sensitive to detect the small quantity of energy which one has to deal. I therefore hope to obtain some results which will be conclusive on this point.

To Professor Joseph E. Ames, under whose direction this work was done, I am greatly indebted chiefly for his valuable suggestions and his untiring interest.

BIOGRAPHICAL SKETCH.

James Temple Porter was born in Bath County, Virginia, September 29, 1873. At the age of 13 he entered the preparatory department of St. Johns College, Annapolis, Md. In the fall of 1891 after having been out of school for a year and a half he matriculated at Randolph-Macon College, Ashland, Virginia, from which institution he received the degree of Bachelor of Arts in June 1895. The two following years were spent, one as instructor in Martha Washington College, Abingdon, Va. and the other as instructor in Randolph-Macon Academy, Front Royal, Va. In the fall of 1897 he returned to Randolph-Macon College as a student, and in June 1898 was admitted to the degree of Master of Arts. From September 1898 to June 1901 he was again instructor in Randolph-Macon Academy. In October 1901 he entered Johns Hopkins University where, during the past four years, he has as a graduate student in the department of Physics attended courses under Professors Ames, Wood and Bliss and Associate Professors

• **APPLIED & TECHNICAL**

[illegible]

Whitehead and Cohen. From 1901 to 1903 he held a Virginia scholarship, from 1903-1904 a position as Student Assistant in Physics, and during the present session has held a Fellowship in the same department.

Wilkes and Coker. From 1901 to 1905 he held a 1st-
class certificate, from 1905-1906 a position as assistant
teacher in physics, and during the present session has
held a fellowship in the same department.



